

Extending Community of Practice (CoP) beyond institutes to inculcate STEM habits in society

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Bringing the focus on building STEM Habits

Science, Technology, Engineering, Mathematics (STEM) is a broad term to include academic disciplines. STEM habits are required for learning about them and developing scientific attitude. Indian Education system faces severe challenges in inculcating STEM habits and scientific attitude in students.

Developing scientific attitude is an integral part of education, but is still left on the periphery. The goals of learning should be promoting scientific attitude as a learning outcome for the larger society (Kaushal, 2018).

It is an attempt in this study to demonstrate that STEM Habits contribute directly in developing scientific attitude/temper.

This work is carried out in the context of a Community of Practice named as CUBE.

STEM Habits and Community of Practice (CoP)

Collaboratively Understanding Biology Education (CUBE) is a Community of Practice of students, teachers, scientists and citizens, created to engage members from different parts of the country through a network of Home Labs.

It was initiated at HBCSE, TIFR in collaboration with Kishore Bharati.

CUBE Home Lab network is a student-driven community created to do research projects in frugal conditions and local surroundings.

A key feature of the community is the conversations among the members of the network, facilitated by instant messaging, social networking and online video conferencing (VC) platform.

Conversations facilitated over the VC platform are called **Chatshaala sessions** that take place every evening.

Theoretical Framework

Pierre Bourdieu's Cultural Reproduction and Habitus

Social actors in a community have the capacity to actively impose and engage their cultural productions and symbolic systems thus playing an essential role in the reproduction of the culture of a community.

Just as Bourdieu's Habitus is shaped by the structural position of the actors and generates action, the development of STEM habits is shaped by the practices participants' engage being in the community.

Participants themselves join the community without any processes of selection. Hence, self-selection and participation continuity happens by the participant's internalization of the mannerisms and behaviors exhibited by other community members and perceived as conducive for themselves.

The CUBE CoP helps in the creation of conditions to build STEM habits and ensures their reproduction, akin to Bourdieu's cultural capital, that supports the development of STEM thinking in society.

Community of Practice & Cultural Reproduction

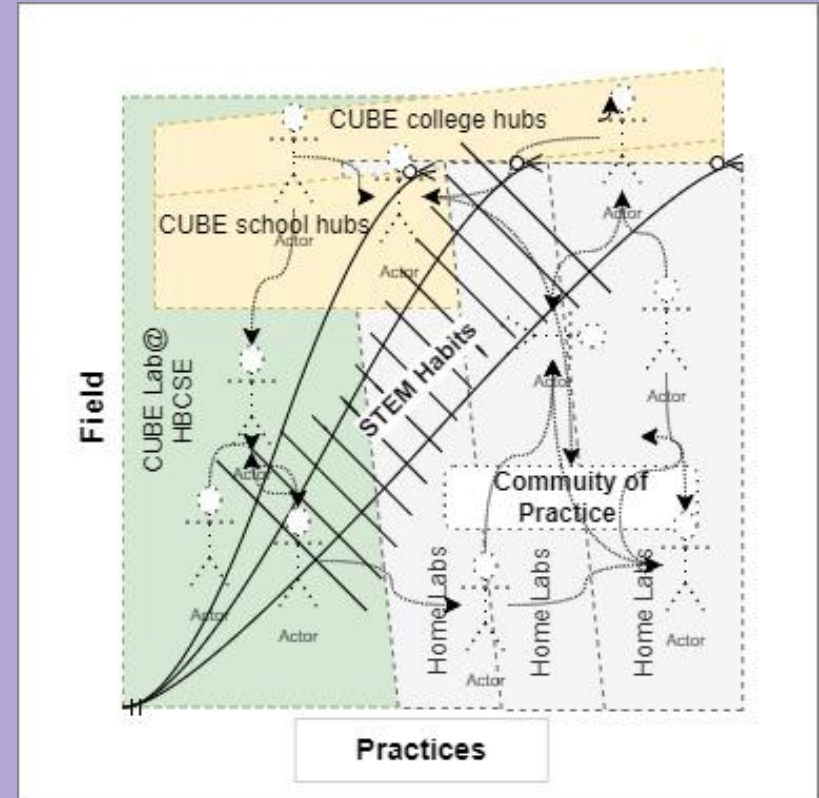
Field is the networked community of CUBE including School and College hubs and Home Labs.

Practices are STEM activities done in frugal settings.

Social actors are engaged in STEM activities (practices) in the field.

Culturally-driven STEM Habits thus develop through engagement of actors in practices and dissipate across the field.

Social actors thus shape the field as well as the habitus of other members and themselves.



Habits

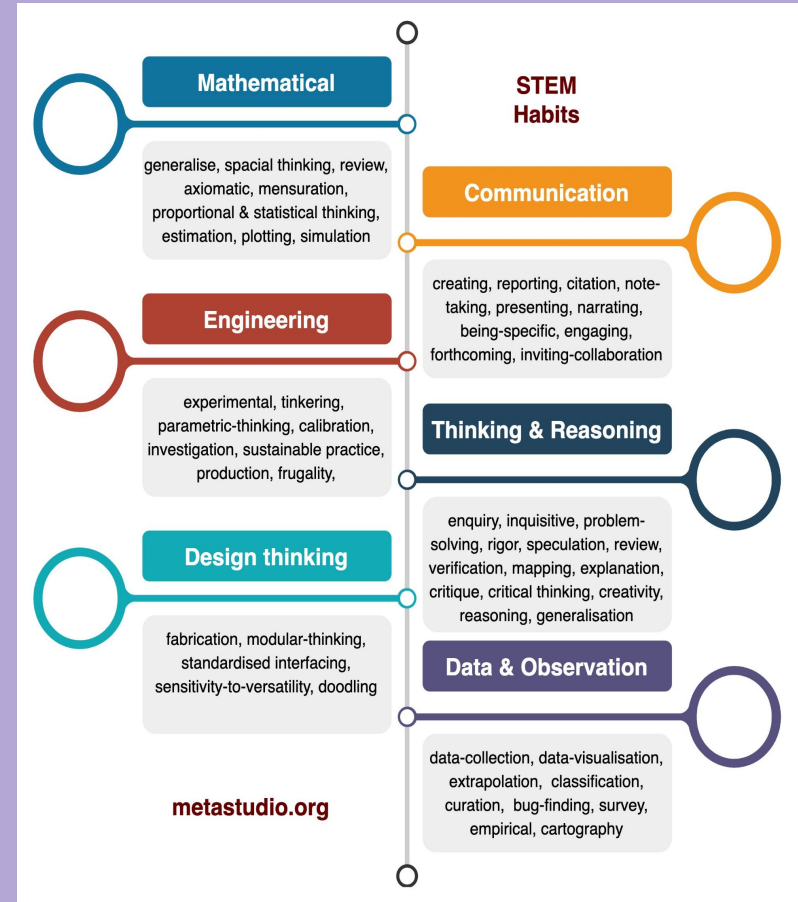
Only when certain actions are repeated a couple of times in multiple contexts, they could become a habit.

STEM Habits

STEM habits are inspired by Bourdieu's habitus.

STEM habits are the cultural capital reproduced by the CUBE CoP.

These habits are part of culture of doing science. STEM habits are thus linked with the social culture.



Source: <https://metastudio.org/t/what-are-stem-habits/52>

Research Questions










In this study we seek to find answers to following question:

- 1) What kind of STEM habits are developed within the CUBE CoP?
- 2) Do these STEM habits shape scientific thinking in the members of this CoP?
- 3) What kind of socio-cultural and technical environment is necessary for developing and extending STEM habits in society?

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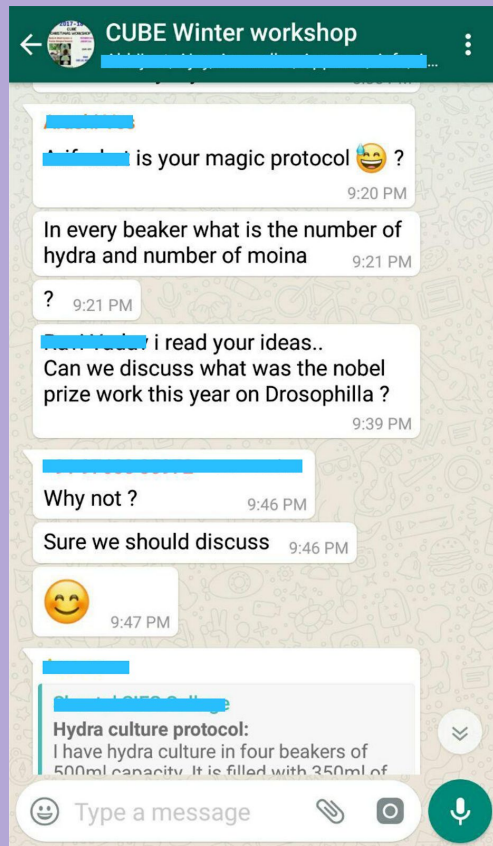
We seek to analyze the interactions- discourses and whiteboard inscriptions and describe 2 case studies in the context of practices undertaken by members. We use a list of STEM Habits as codes for the above analysis.

Members are granted Badges in the form of STEM habits

 Collaborator 50 Works passionately with a team in a project.	 Creative 60 Who thinks different or finds alternative ways.	 Critical Thinker 27 Who looks at a problem from multiple perspectives and often questions assumptions.
 Curator 16 Organizes resources based on classifiable properties and creates an inventory or a library of things to locate them easily.	 Data Collector 20 Who collects data about a phenomenon or an event in a project to facilitate an investigation.	 Data Visualiser 5 One who presents data in a format that makes the pattern clear in a plot/graph.
 Designer 57 Who makes a plan of where, when and how of components in a system.	 Designs Standards Who designs a product to ensure compatibility, reproducibility, and adaptability.	 Detective 3 Looking for something missing/unknown.

(developed in consultation with Knowledge lab, HBCSE, TIFR) Source: <https://metastudio.org/badges>

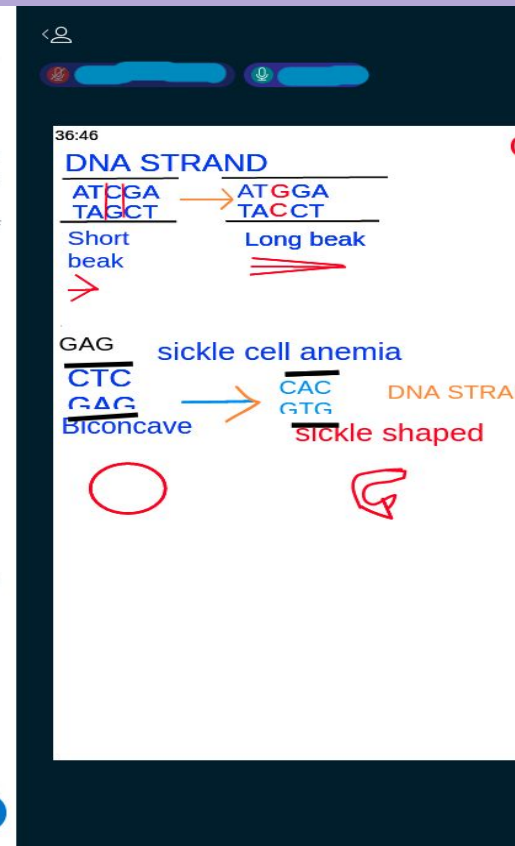
Glimpses of the community interactions



Instant Messaging Conversations



Chatshaala VC Platform mode of conversations & expressions






Research Methodology

1. **Episodes of interactions** (unit of analysis) are taken from **instant messaging groups**.
2. The conversations are coded for the STEM Habits.
3. **White board inscriptions** from **Chatshaala** are also coded for STEM Habits.
4. **Case studies** are also taken based on the conversations during the **Chatshaala**.
5. The STEM Habits are analysed for their recurrence in the three groups of episodes.
6. Two case studies have also been treated using the same codes.

Analysis of White Board inscriptions: Episode-1 (Nail Growth Studies)

Img: 1

Img: 2

			4/6 mm/week	 Growth: ~4.5mm
Week-1	Week-2	Week-3	Week-4	Week-5 (13 Jan 2021)
 Growth: ~7mm	 Growth: ~7.5mm	 Growth: ~7.5mm	 Growth: ~8mm	 Growth: ~8.5mm
Week-6 (20 Jan 2021)	Week-7	Week-8	Week-9	Week-10

Sample's Initial	Age	Gender	Hand	Date of Marking	Week 1		Week 2		Week 3		Week 4		Week 5	
					Date	Growth	Date	Growth	Date	Growth	Date	Growth	Date	Growth
MHKU	46	M	L	10 Dec			1/12/20	3	9/1/21	4	19/1/21	6		
UKA	70	M	L	10 Dec	18/12/20	0	31/12/20	2	9/1/20	3.5	19/1/21	4	29/1/21	5
BMA	64	F	L	10 Dec	18/12/20	1	31/12/20	2	9/01/21	4.5	19/1/21	5.5	29/1/21	6
SPA	38	F	L	10 Dec	18/12/20	0.25	31/12/20	2	9/1/21	5	19/1/21	5	29/1/21	5
A	53	F	L	29 April	6/5/21	1	13/5/21	3	20/5/21	3	27/5/21	3.5		
B	52	M	L	29 April	6/5/21	0.5	13/5/21	2						
i) DMK	19	M	L	26 Jan	2/2/21	1	9/2/21	3	16/2/21	3.5	23/2/21	4	2/3/21	5
ii) DMK	19	M	L	19 Jun	26/6/21	0.8	3/7/21	1.68	11/7/21	2.63	17/7/21	3.3	25/7/21	4.36
i) MIK	48	M	L	26 Jan	2/2/21	1	9/2/21	2	18/2/21	2	25/2/21	3	2/3/21	3.5
ii) MIK	48	M	L	19 Jun	26/6/21	0.86	3/7/21	1.85	11/7/21	2.88	17/7/21	3.8	25/7/21	4.55
i) CIK	39	M	L	26 Jan	2/2/21	0.5	9/2/21	1.5	16/2/21	2	23/2/21	3.5	2/3/21	4
ii) CIK	39	M	L	29 Jun	7/3/21	1.53	15/7/21	1.78						
VMK	45	F	L	19 Jun	26/6/21	0.74	3/7/21	1.2	11/7/21	2.2	17/7/21	2.58	25/7/21	4.05
ViK	15	M	L	19 Jun	26/6/21	1.9	3/7/21	3.1	11/7/21	3.53	17/7/21	4.74	25/7/21	5.16
SIK	37	M	L	20 Jun	27/6/21	1	8/3/21	2.5	11/7/21	2.8	25/7/21	4.05		
ICP	19	F	L	29 Jan	5/2/2021	2	2/2/202	3	9/2/202	4	6/2/202	5	3/3/2021	6

Img 1 & Img 2: STEM Habits: Data Collector, Designer, Surveyor, Classifier, Empirical, Modeler, Modular Thinker

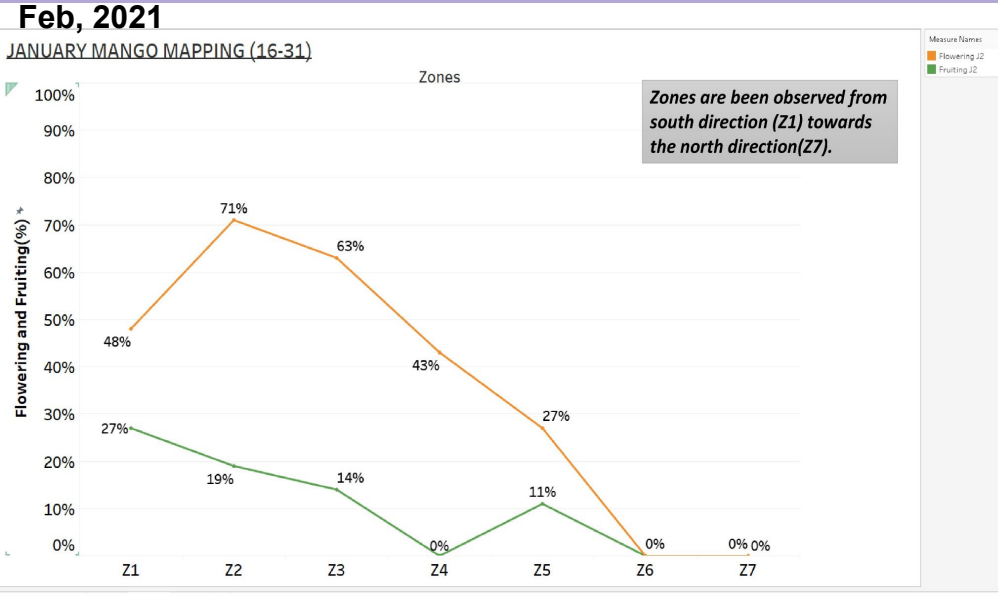
Analysis of Interactions: Episode-1 (Nail Growth Studies)

(Date: 11th Dec, 2019)

Student no	Sample Transcript	STEM Habits	Description
S1	Since we have a lot of data since elections in Maharashtra can we start measuring the nail growth in these pics?	Collaborator, Data Collector	S1 is collaborating, collecting data
S2	The nail growth is from 1.3cm base of the nail to 0.7cm that is 0.6cm total If we count the number of days since voting to pic there are 51days So 0.6cm or 6mm or 6000microns growth in 51days hence in one day the nail growth in this Male 37 yrs will be $6000 \div 51 = 117.65$ microns per day.	Keen Observer, Mensurer	S2 is observing and measuring the nail growth
S3	Finger Nail with the Mark was taken on *10th December 2020* and also after 27 Days that's on *06th Jan 2021*. It has been shown that Marked has moved and the Gap was measured *5mm*	Data collector, Mensurer, Keen Observer	S3 is sharing his data, observing and measuring the nail growth
S1	Let us compare this data with readings from other age groups and gender	Collaborator, Comparative Thinker	S1 is asking for comparative study and collaboration

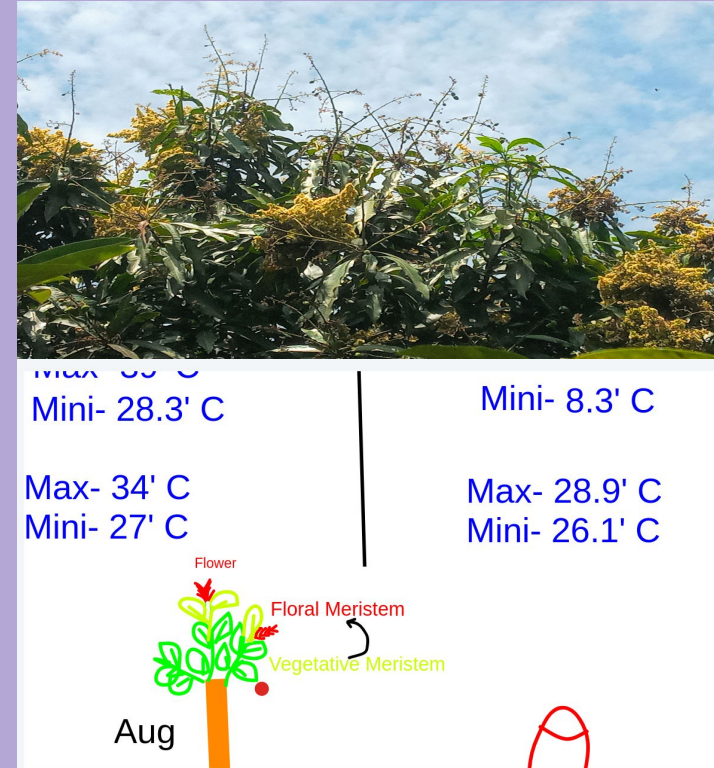
Analysis of White Board inscriptions: Episode-2 (Mango Tree Mapping Studies)

Img: 3



<https://metastudio.org/t/mango-mapping-line-graph-plots-nov-jan/11067>

Img 3: STEM Habits like Plotter, Surveyor, Data Collector, Classifier, Data Visualizer, Modeler, Modular Thinker **Img 4:** Objective Thinker, Generalize, Reasoner, Mensurer



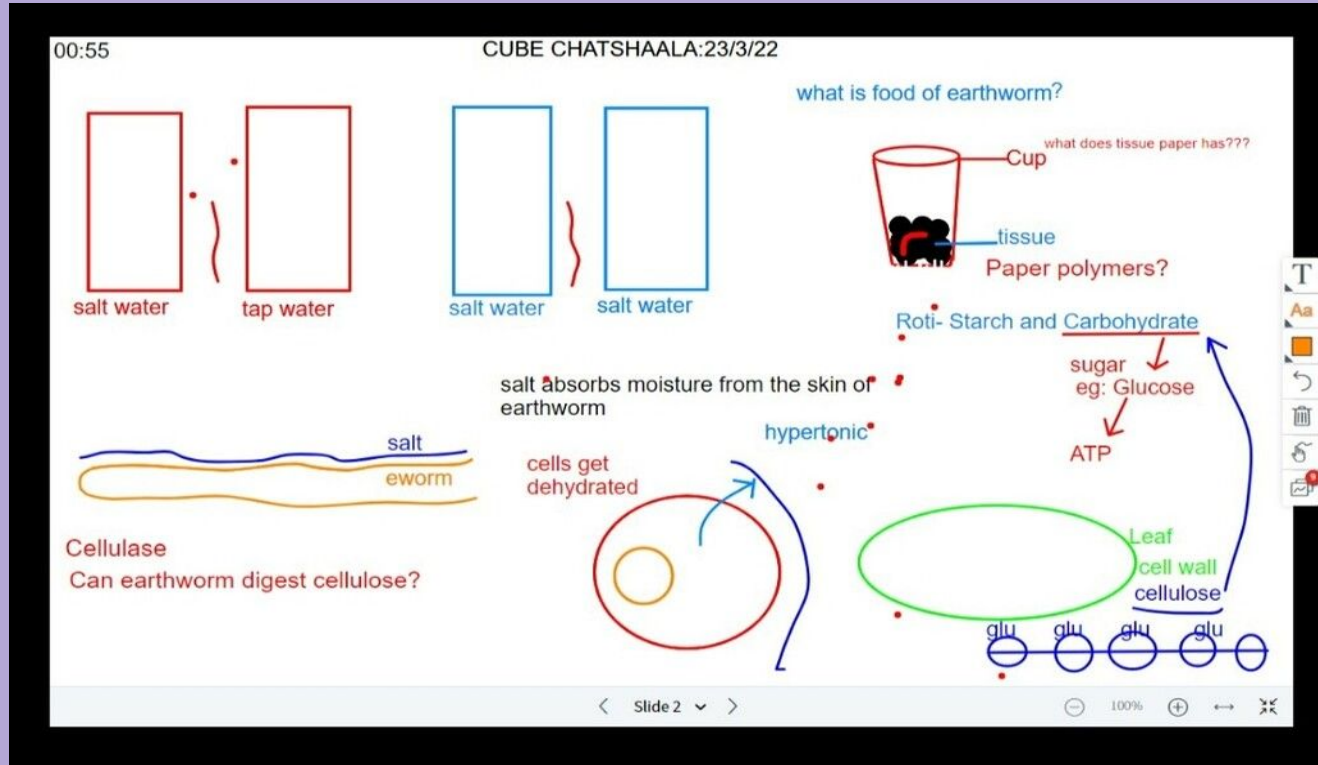
Img: 4

Analysis of Interactions: Episode-2 (Mango Tree Mapping Studies)

Date: 14th Aug, 2021

Student no	Sample Transcript	STEM Habits	Description
S1	Ohkay, found it in the picture. Sorry. But what do others think? Are there mango trees still fruiting anywhere in the south!? Folks from Kerala?	Enquirer, Collaborator	S1 is asking questions and asking for collaboration
S2	Yes, not fruiting but flowering in August. When i travelling in bus i am observed this kind. Some trees are Flowering in different areas in thrissur. But i couldn't take photo of it, I missed a great science! Sorry for that.	Keen Observer, Critical Thinker	S2 is providing observation and thinking critically and reflection on mistake
S1	Yaay! But we have our first report of flowering this season! Can you roughly say when you observed them?	Enquirer, Engager, Evidence Seeker	S1 is inquiring question to get more details, asking for evidence and engaging S2
S2	Sure, In total I observed 5 trees. That too in different places in thrissur, Kerala . One is in good bloom. The rest I saw only 1,2 flowers out of 4.	Data Collector, Repeated Observation	S2 is sharing collected data and repeated observations

Analysis of White Board Inscriptions: Episode-3 (Home Lab Experiments)



Img: 5

Img 5: STEM Habits like Enquirer, Experimenter, Designer, Reasoner, Explainer, Empirical

Analysis of Interactions: Episode-3 (Home Lab Experiments)

Date: 12th July, 2020

Student no	Sample Transcript	STEM Habits	Description
S1	We observed that if we place, say, fresh tomatoes and ripe tomatoes, flies will be more attracted towards ripened ones than the fresh. So, yes, flies are more attracted towards ripe ones. But there is also a reason.	Experimenter Keen observer	S1 has done an experiment and made specific observations
S3	So which are the odour compounds present in the tomato since u already have done it @S1	Enquirer Evidence Seeker	S3 is inquiring about the details and seeking evidence from S1
S4	"I observed that the flies preferably gathered on the mango slice in a plate and avoided my bottle next to it which had the ripened banana bait" When this experiment was done, there must have been many variables in this! We don't know whether how many slices of mango, banana (was a whole banana kept or just the peel?) were kept. At what distance from each other? There is a possibility that the smell of the mango must have been more, overpowered the banana due to which more flies were seen on the mango bait. Another variable here is that the mango slice was kept in an open plate with a larger surface area whereas the banana (whole or peel, no idea) was kept in a bottle. Logically thinking, where will the smell be more?	Keen Observer Experimenter Explainer Engager	S4 is providing his observations on another experiment, and enquiring about factors in design of the experiment. S4 is also providing explanation with possible reasons behind the observations, and engaging with others by opening the discussion with questions.
S6	Yes, I agree with u @S4. Why not we check on the compounds that give this aroma to the flies that get attracted to it? So that we can conclude what is the secret of this flies for their attraction to strong odours?	Evidence Seeker Enquirer Engager	S6 is inquiring and seeking details from S1 to come to a conclusion.
S1	Fruitfly are attracted to fermenting process, and to alcoholic smell for mating and egg laying. Fermentation is more active in ripe fruits rather than fresh.	Explainer	S1 is providing information and explaining it to provide an idea

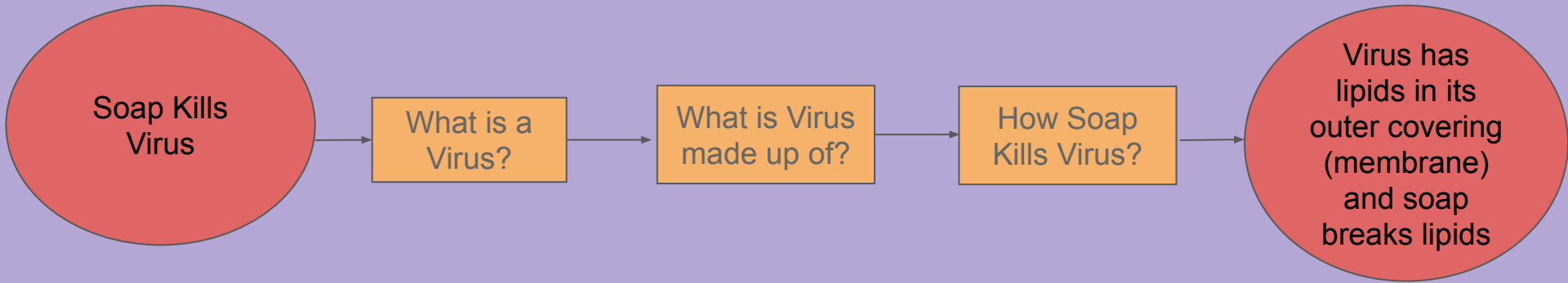
Possible Role of STEM Habits in STEM Thinking

Case 1

During pandemic in several advertisements by government as well as commercial outlets about use of soap to keep Covid-19 away. In CUBE Chatshaala there was a discussion on why do we use soap? Students participated in the discussion where they shared about increasing Coronavirus infections. The discussion went on handwashing practice with soap to kill Coronavirus. There were further questions on how soap could kill the virus. Another question came what is a virus? Some students said germ. Further discussions went to explore deeper on structure of virus which has lipid as an outer membrane, which dissolves in soap killing bacteria. Students also asked question why virus cannot survive outside body? The discussion also explained how virus lacks metabolic substances needed to reproduce on its own hence it can only remain alive and reproduce in human body. Students also asked question how can they use soap to break even plant cells like virus cell.

<https://metastudio.org/t/599th-day-of-cube-chatshaala-continuation-regarding-the-role-of-detergents-in-floral-dip-and-in-corona-prevention/12929>

Analysing the possible role of STEM Habits in STEM Thinking



General
Information

BlackBox

**Inquiring,
Collecting
Information**

**Collecting
Evidences,
Sharing
Information**

**Collecting &
Sharing
Information,
Reasoning,
Explaining**

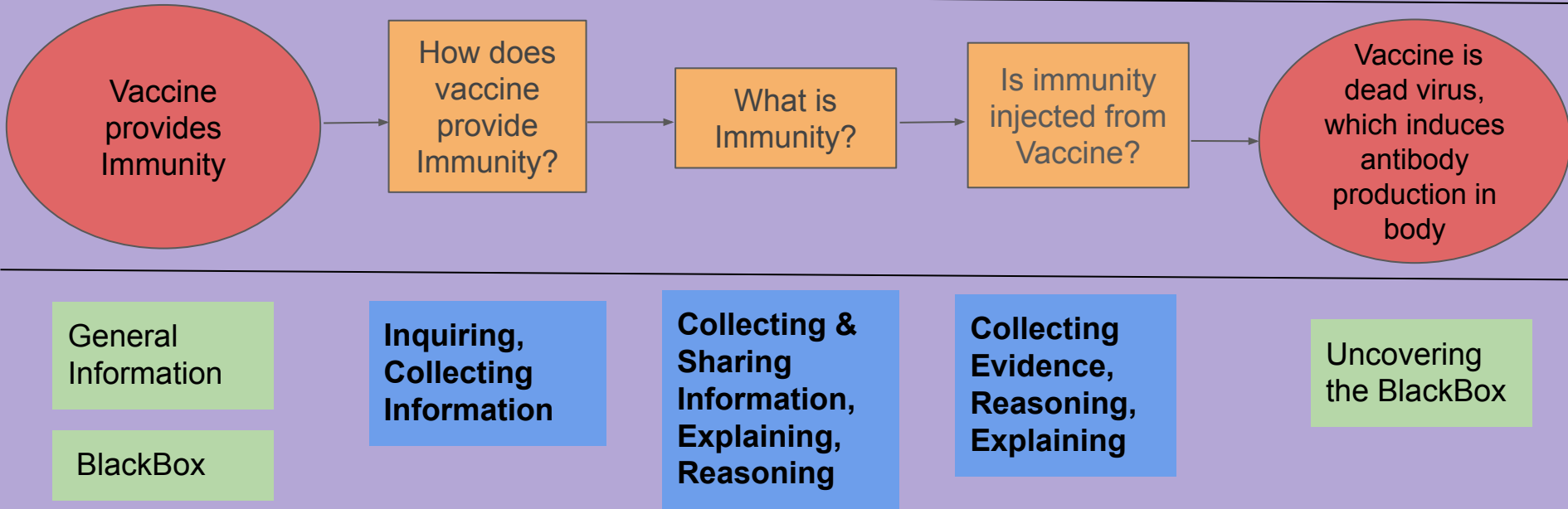
Uncovering
the BlackBox

Case 2

There were a lot of popular beliefs about immunity, boosting immunity and vaccine may cause infection during Covid pandemic as a aversion to vaccine. The discussion started in order to understand what is immunity? How does vaccine provide immunity? Fresh students from different home lab communities during Chatshaala session shared that vaccine itself is virus but its a killed virus. The vaccine hence promotes antibody production against virus by getting stimulus of dead virus. They first time got aware that immunity is not introduced from outside through vaccine, but is produced by body itself on an external trigger.

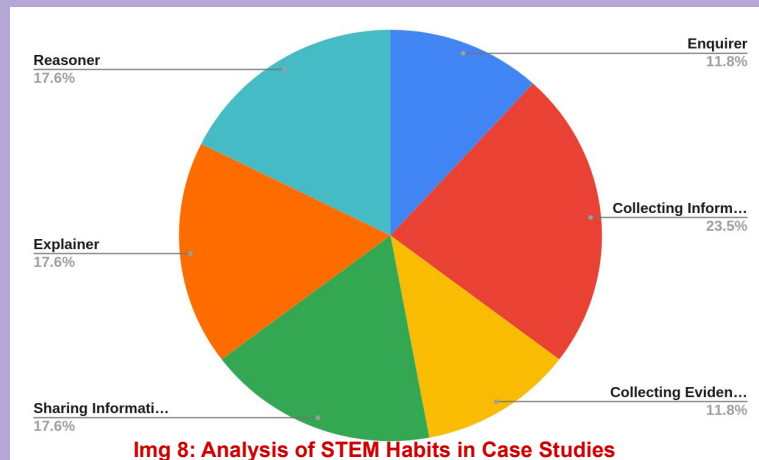
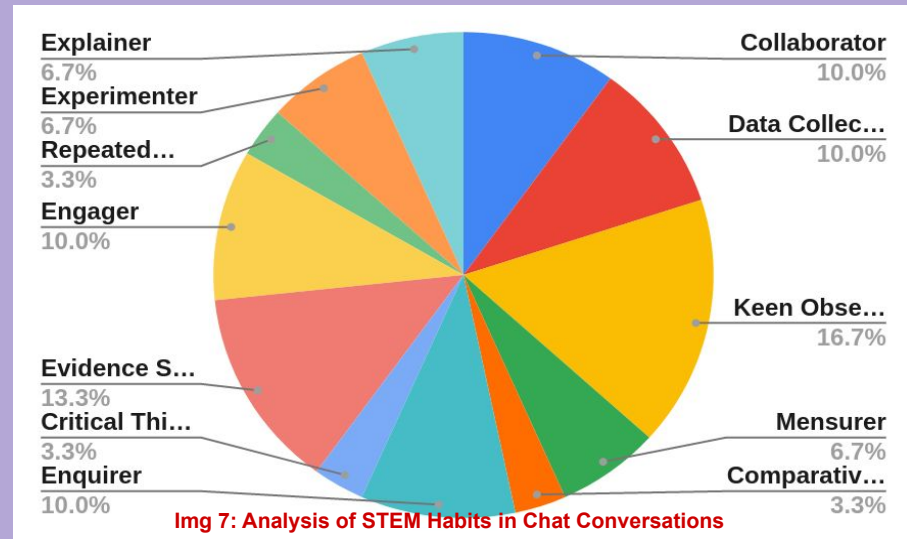
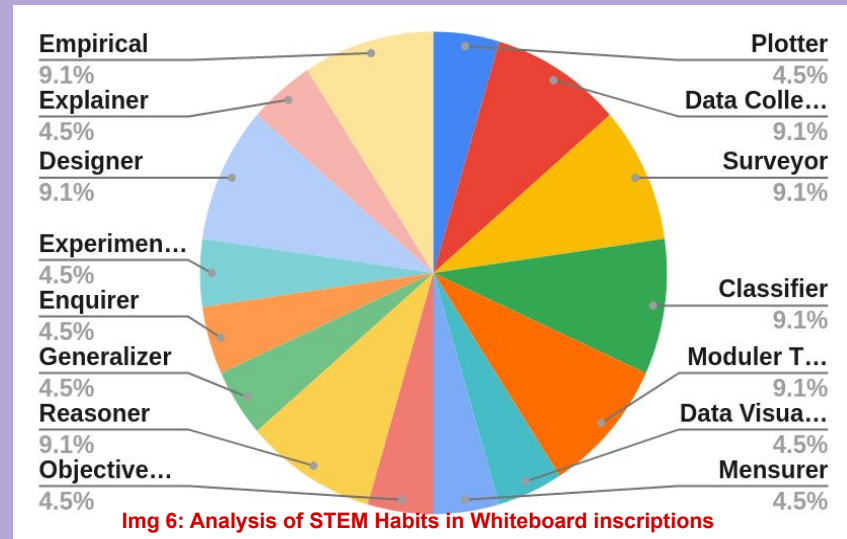
<https://metastudio.org/t/cube-curiosity-lab-origin-existence-and-evolution-of-life-series/13186/3>

Analysing the possible role of STEM Habits in STEM Thinking

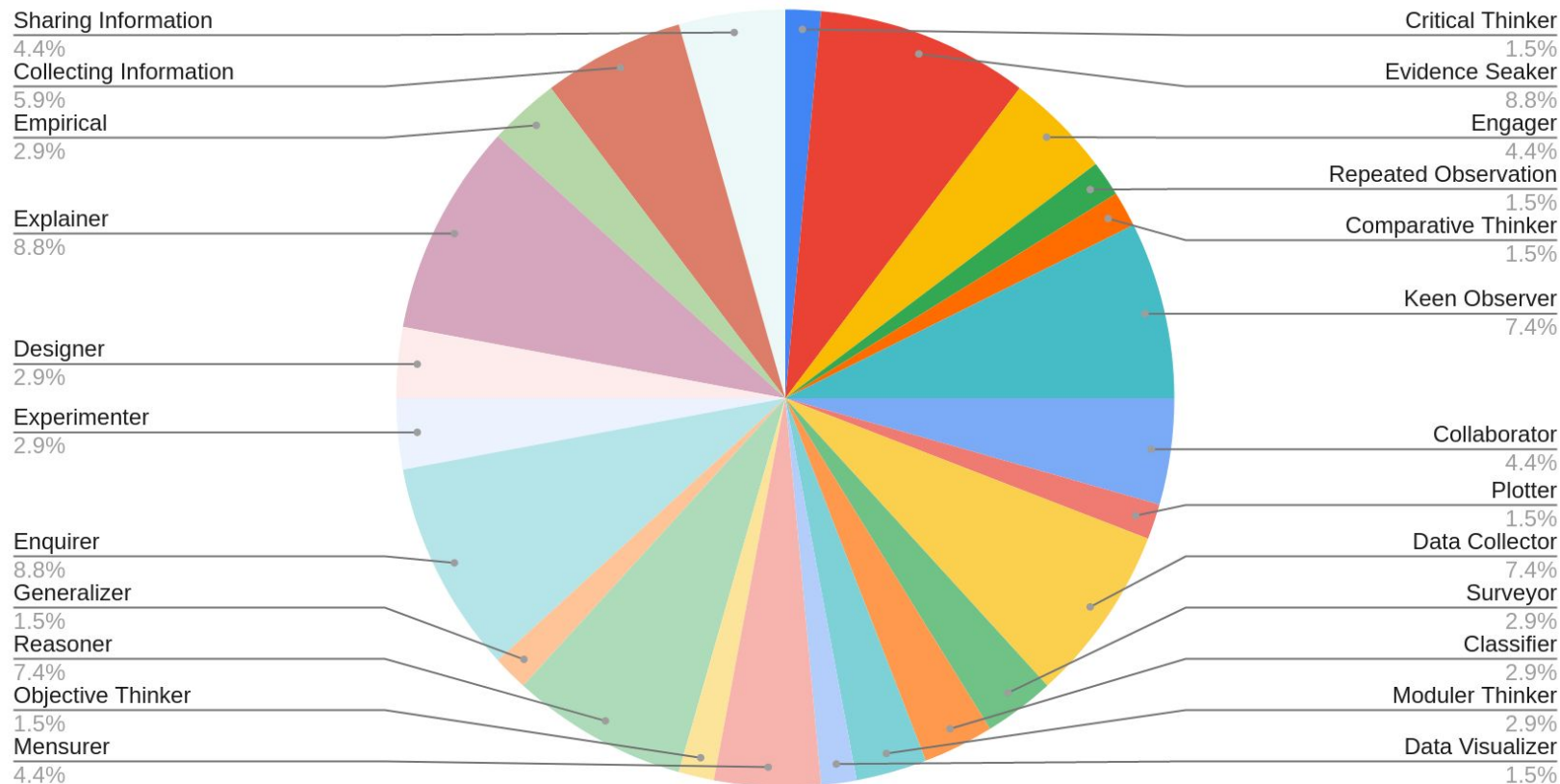


STEM Habits of asking questions, probing, doubting, collecting information, collecting evidences, arguing by sharing alternative views, explaining, reasoning are developed. They are important in enhancing critical scientific thinking in members. It also helps in unboxing the 'blackboxes' they encounter in their everyday lives.

Data Analysis: Cultural Reproduction of STEM Habits in the Community



Data Analysis: Cultural Reproduction of STEM Habits in the Community



Img 9: Analysis of STEM Habits- Combined Chart for all modes of expression in the Community

Results and Discussion

The study focuses on identifying STEM habits developed through student-driven CoP, operating in the home lab settings.

Certain STEM Habits such as **Data Collector, Keen Observer, Enquirer, Collaborator, Evidence Seeker, Explainer, Reasoner** are seen to be repeated and developing through Chat conversations facilitated by instant messaging and Chatshaala.

While other STEM Habits such as **Designer, Modular Thinker, Data Collector, Surveyor, Classifier, Data Visualizer** are repeated and developed through the culture of interactions using whiteboard as a mode of expression.

Different modalities (Conversations and Whiteboard expression) are employed by the CoP which helps to develop different kinds of STEM Habits in its members.

In this study we demonstrate **Cultural Reproduction of STEM Habits**, as per Bourdieu's framework, for dissipating STEM culture across the network of Home Labs community.

The study also shows possible role of STEM Habits in uncovering blackboxes encountered in our daily lives..₂₄

Conclusion

We demonstrate the design of a social and cultural field needed to reproduce and propagate STEM habits.

The study shows the role of student-driven CoPs as a socio-cultural environment which can act as a powerful model to propagate and enhance STEM habits in society, even beyond institutions.

We emphasize that developing STEM habits needs to be the central focus of education, to increase scientific temperament in a society.

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Thank You